This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problems Mailbox.

1215221

PATENT SPECIFICATION

(11) 1215221

DRAWINGS ATTACHED

(21) Application No. 2124/68 (22) Filed 15 Jan. 1968
(31) Convention Application No. 582 (32) Filed 16 Jan. 1967 in
(33) Sweden (SW)
(45) Complete Specification published 9 Dec. 1970
(51) International Classification F 16 j 15/34
(52) Index at acceptance
F2B 13C2E1A1 13C2E1C 13C2F4 13C9

THE PATENT OFFICE LONDON

NATIONAL REFERENCE LIBRARY OF SCIENCE AND INVENTION

(54) IMPROVEMENTS IN OR RELATING TO SEALS BETWEEN ROTATING AND FIXED PARTS

(71) We, FORSHEDA GUMMIFABRIK AB, a Swedish Body Corporate of Forsheda, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

At one time seals for rotating shafts were divided into two groups, frictional seals and non-frictional seals, but during more recent years a further group has been introduced. The third group of seals are known as hydrodynamic seals which can be said to be something in between a frictional and a non-frictional seal, since a lubricating liquid is sucked in between, and thereby separates, two sealing surfaces which rotate relative to each other and which in a stationary condition rest against each other. Hitherto hydrodynamic seals have usually functioned by virtue of a pumping effect which is obtained in accordance with a spiral of helix principle, that is to say that a radial seal is provided with one or several complete or discontinuous helix shaped grooves and an axial seal with similar spiral grooves. The reason that hydrodynamic seals are coming into use more and more is two fold. A more effective seal is obtained that when using an ordinary frictional seal owing to the fact that on rotation a spiral or helix formed groove gives rise to a pumping effect and transports the liquid which is being sealed (normally oil) away from the sealing location. This pumping effect is also obtained if there is a very low sealing pressure between the surfaces forming the seal. The power losses are therefore low when employing this type of seal. A disadvantage however of this type of seal is that the positive sealing effect is obtained in one rotational direction only, depending on the hand of the grooves. This means that a hydrodynamic seal cannot be used in applications where the shaft is required to rotate in both directions.

The present invention relates to a hydrodynamic seal between one rotating and one stationary part comprising two slide rings, one secured on each part, axially contacting and sliding against each other under a certain pressure.

The disadvantage mentioned above pertaining to known hydrodynamic seals has been eliminated by the invention in the following way. The contact surface of the slide ring of the rotating part is provided with one or several essentially radial (as hereinafter defined) recesses or ridges which on rotation function as radial vanes in a centrifugal pump. By this pumping effect the sealing effect is increased.

According to the present invention there is provided a seal between one rotating part and one fixed part, comprising two slide rings, one secured on each part, axially contacting and sliding against each other under a certain pressure wherein the slide ring of the rotary provided on the contact surface thereof with part is made of a resilient material and one or more essentially radial (as hereinafter defined) recesses or ridges.

These recesses and ridges can be arranged in many ways. They can for example be placed in the surface of the rotating slide ring either inside a continuous annular sealing surface or between two or several such surfaces. Ridges and recesses can also be placed on the surface opposite the sealing surface. The recesses can extend axially through the whole slide ring and can be positioned at the edge of the ring.

In order to clarify the different aspects of the invention a number of representative design forms are described below by way of example with reference to the accompanying drawings in which:

Figure 1a shows an application of the invention on a V-ring,

Figures 1b and 1c illustrate on a larger scale two views of a recess in accordance with Figure 1a,

Figures 2 and 3a show sections of two sealings rings of rubber which constitute representative design forms of the invention.

Figure 3b is an end view of the sealing ring shown in Figure 3a,

Figures 4 and 5 shows sections of alternative forms of recesses and ridges,

Figure 6 illustrates a seal in accordance with the invention which is easy to produce,

Figure 6b shows a section of the same seal in a mounted position,

Figures 7, 8, 9 and 10, show different means of arranging the radial recesses or ridges on the sealing surface of the slide ring.

In Figure 1 a rubber V-ring is denoted 11. The V-ring 11 is fixed in position on a rotating shaft 12 by means of the inherent tension in the material of the ring and a lip 13 of the seal rubs against a sealing surface 14 on a stationary machine component. The sealing lip 13 and the sealing surface 14 are respectively the equivalent of the "rotating and stationary slide rings" referred to previously. In the following both these denotations will be considered as being synonymous from a functional point of view. The peripheral portion of the sealing lip 13 is provided with one or several recesses 15. Figures 1b and 1c show the appearance of these recesses on a larger scale. Figure 1b is the same view as in Figure 1a and Figure 1c is a view showing the recess according to Figure 1b seen in a direction towards the sealing surface. The recess 15 is formed essentially as a semi-cylinder. However, the wall 17 is slightly tapered, which on rotation gives rise to a slight axial force towards the sealing surface on one side of the wall which increases the normal pressure of the sealing lip. This has a positive effect on the type of seal described, the lip of which, under the effect of the centrifugal forces, loses part of its normal pressure. A V-ring can withstand a certain axial movement. It is thus advantageous that the complete length of the lip is exploited to the greatest extent. By making the recesses very small but at the same time increasing their number the same effect can be obtained as with a small number of deep recesses and with the advantage that the uninterrupted sealing surface 16 will be located as far as possible towards the lip and thereby permit maximal axial movement between the sealing wall 14 and the shaft 12. This uninterrupted sealing surface guarantees a perfect seal when stationary.

Figure 2 shows a further seal to which the idea of the invention can be applied. A rubber sealing ring 21 is fixed to a shaft 22 by means of a metal ring 27 fixed in the body of the sealing ring which is required in order to hold a resilient sealing lip 23 in the correct position relative to a sealing wall 24. The sealing surface of the lip is provided with a number of radial grooves 25 which extend from the shaft 22 outwards to a continuous annular sealing surface 26 the width of which is adapted so that the seal fulfils the following demands. It must be able to seal when stationary i.e. by means of an uninterrupted sealing surface (see above under description of Figure 1), and it must allow the passage back of leaking oil if any. The pumping effect due to the groove 25 thereby creates a back pressure opposing leakage of the fluid.

The circumstance that the pressure of the sealing lip 23 against the sealing surface decreases with increasing rotational speed depending on the effect of the centrifugal forces on the lip can be partly eliminated in the manner illustrated in Figure 3a. The lip 33 is provided with recesses 35 on the inside and also with ridges or recesses 351 on the opposite side, the direction of which is essentially radial outwards. In the description and the claims the words "essentially radial" mean that a deviation from an exact radial direction of each and every ridge and recess can be considerable, but as the basic idea of the invention is to achieve an increased sealing effect on rotation in both directions the total effect of all the ridges and recesses must be similar to that which is obtained with ridges and recesses which are exactly radial. Figure 3b illustrates a relevant location of recesses 35 which is correct according to the invention. The recesses 35 are arranged so that their directions deviate from the radial direction but the mutual effect is the same as that of exact radial recesses.

The sealing lip 53 shown in Figure 4 is provided with recesses 55 on the inside of the peripheral portion. The recesses 55 do not perforate the lip 53. This means that the lip 53 is subjected on rotation to a force which tends to lift the lip from the sealing surface 54. The effect of this force can be reduced or eliminated by means of an arrangement such as the Figure illustrates. The sealing ring 51 clamps with its inherent tension round the shaft 52. The inherent tension is increased by means of a garter spring 58 which rests on a tapered surface 57. The main task of the garter ring is to transfer pressure to the lip 53. By selecting suitable values for the angle of taper and the tension, the garter ring can be made to roll up and down the tapered surface and thereby permit a certain axial movement between the sealing wall 54 and the shaft 52. The normal value of the conicity should not exceed 30 degrees.

A hydrodynamic seal must seal in a stationary position as is the case with an ordinary frictional seal. This means that the pressure between the slide rings must be such that the film which the medium (normally oil) forms is broken down so that the oil is not sucked in between the sealing surfaces due to capillary forces. The important factor here is the specific surface pressure, thus by making the sealing surface of the slide ring narrow, a lower sealing pressure can be per-

mitted, or in other words the smaller the sealing surface the lower the sealing pressure. This means expressed in another manner that a constant sealing pressure achieves an improved sealing effect if the sealing surface is kept smaller.

A form of the invention which has particularly good sealing properties in a stationary condition is illustrated in Figure 5.

A sealing lip 63 is provided with recesses 65 located round the inside of a peripheral portion 68. An annular groove 67 which extends deeply into the lip 63 separates the peripheral portion 68 of the lip provided with recesses 65 from the remainder of the lip 63. The groove 67 and the section of the lip 63 form a sharp edge 66 which contacts the sealing surface 64.

Figures 6a and 6b show a form of the manufacturing point of view. The raw material is in the form of a tube the exterior of which is provided with longitudinal grooves or serrations 75 the appearance of which may be illustrated in Figure 10 which is an end view of such a tube suitable for the purpose. A cut 79 is made through almost the complete section. A tapered surface 710 is cut or ground and the ring 71 separated from the rest of the tube. The ring 71 can now be stretched round a shaft 72 and a conically projecting sealing lip 73 thus formed contacts a sealing surface 74. The serrations 75 in the outer portion of the lip will function as those recesses and ridges described in connection with other Figures. By making a cut 77 in the lip during the manufacturing process thereby almost separating the peripheral portion 78 from the lip the same effect is achieved as accounted for in connection with Figure 5. A sharp edge 76 will thus assure a perfect seal in a stationary location.

A similar effect, is obtained when providing the contact surface of the sealing lip with a checkered pattern as shown in Figure 7. The recesses 95 here have an essentially squared form. Some other patterns with the same effect are shown in Figure 8, where the recesses 105 are exactly squared and in Figure 9 where the form of the recesses 115 is circular.

WHAT WE CLAIM IS:—

1. A seal between one rotating part and one fixed part, comprising two slide rings, one secured on each part, axially contacting and sliding against each other under a certain pressure wherein the slide ring of the rotary part is made of a resilient material and provided on the contact surface thereof with one or more essentially radial (as hereinbefore defined) recesses or ridges.

2. A seal according to claim 1, wherein the recesses are positioned in the contact surface of the slide ring radially outside an annular continuous sealing surface.

3. A seal according to claims 1 or 2, wherein the recesses are open in a radial direction outwards and are located in the peripheral portion of the slide ring outside an annular, continuous sealing surface.

4. A seal according to claim 2 or claim 3, wherein the portion in which the recesses are located is separated from the annular continuous sealing surface by means of a groove or a cut forming a sharp sealing edge.

5. A seal according to claim 3, wherein the recesses are so closely disposed that they form a serrated periphery.

6. A seal according to claim 3 or claim 5, wherein the recess forming surface is laterally tapered thereby increasing the axial pressure between the slide rings.

7. A seal according to claim 1, wherein the side of the slide ring opposite to the contact surface is provided with radial recesses or ridges.

8. A seal according to claim 1, wherein the recesses are located in the contact surface of the slide ring inside an annular continuous sealing surface.

9. A seal according to claim 8, wherein the contact face of the slide ring is provided with a number of concentric annular sealing surfaces and between these radially disposed ridges or recesses.

10. A seal according to claim 1, characterized by a plurality of recesses forming a pattern on the contact face of the rotating slide ring.

11. A seal substantially as hereinbefore described with reference to the accompanying drawings.

FORSHEDA GUMMIFABRIK AB,
Per: Boult, Wade & Tennant,
112, Hatton Garden, London, E.C.1.
Chartered Patent Agents.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1970.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1215221 COMPLETE SPECIFICATION

3 SHEETS This drawing is a reproduction of the Original on a reduced scale

Sheet 1

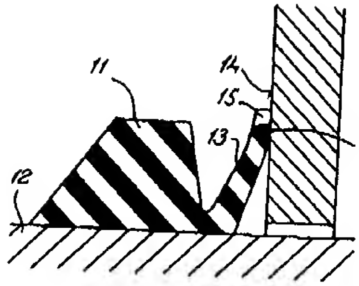


Fig. 1a

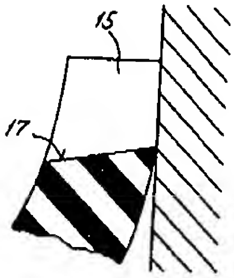


Fig 1b

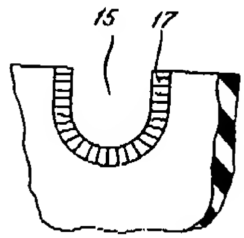


Fig 1c

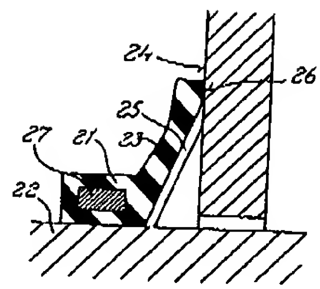


Fig. 2

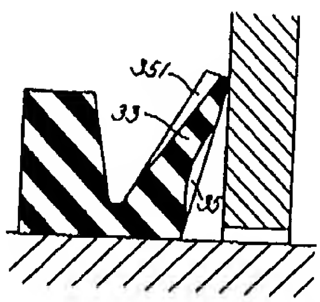


Fig. 3a

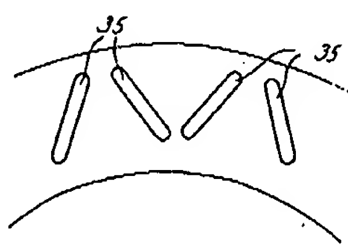


Fig. 3b

1215221 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

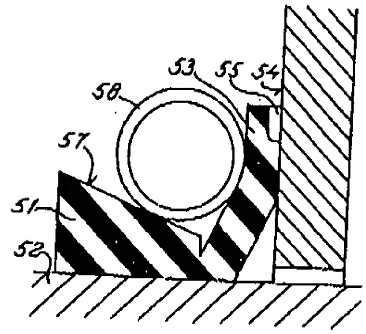


Fig. 4

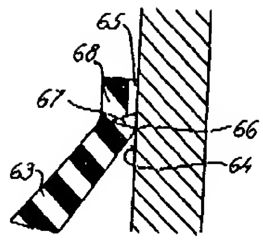
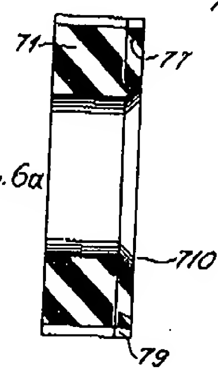


Fig. 5

Fig. 6a



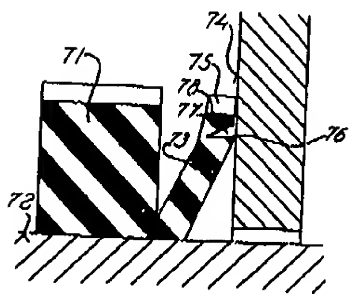


Fig. 6b

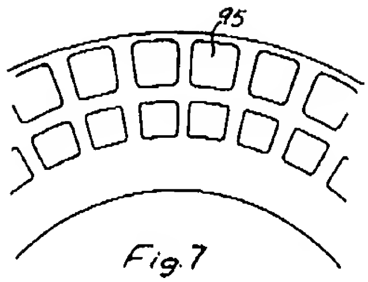


Fig.7

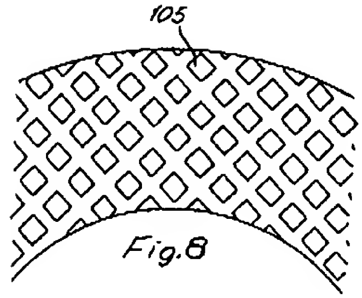


Fig.8

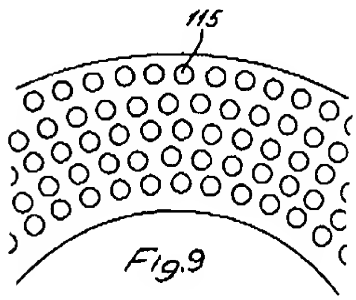


Fig.9

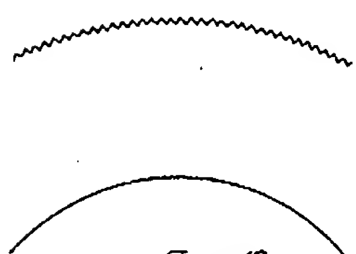


Fig. 10